Progress Report III, 2004

Canebrake Ecosystem Restoration

respectfully submitted to

Strawberry Plains Audubon Sanctuary & Dahomey National Wildlife Refuge

by

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PURPOSE OF RESEARCH

Reintroduction of a declining ecosystem requires a systematic approach and a through understanding of the parameters most greatly affecting establishment. The once dominate southeastern ecosystem, *Arundinaria gigantea* (Walt.) Muhl. canebrake, provided habitat for a number of animal species. A greater than 98% decline in the *A. gigantea* population has resulted in a critically endangered ecosystem (Noss et al. 1995), with extirpation (and perhaps extinction) of many animal species (Remson 1986, Conover 1994, Judziewicz et al. 1999, Brantley and Platt 2001, Platt et al. 2001). Because canebrakes provide a habitat for a diversity of fauna, including endangered species of butterflies (Platt et al. 2001) and avifauna, such as Swainson's warbler (Graves 2001), and because so little is known about the ecology of cane, research is needed to determine factors affecting this unique ecosystem (Thomas et al. 1996).

Historical accounts of canebrakes suggest that they were widespread on floodplains and stream terraces (moist soils, but not inundated for long periods of time) throughout the southeastern United States and tolerated a variety of environmental conditions (Caplenor 1968, Gilliam and Christensen 1986, Baskin et al. 1997, Nelson 1997, Platt and Brantley 1997, Fickle 2001, Fralish and Franklin 2002). However most of the canebrake habitat has been lost due to lack of fire disturbance, replacement by cultivated fields, or use as domestic livestock feed (Hughes 1966, Platt and Brantley 1997). Thus, the current distribution of cane does not necessarily imply its physiological or ecological tolerances for certain environmental conditions. One hint may be the tendency for cane to grow along the edges of forests, suggesting cane is intolerant of shade and perhaps other competition.

The goal of this study is to facilitate reestablishment of *A. gigantea* canebrakes by examining environmental parameters critical to establishment (competition, light levels, soil moisture and nutrients). Field studies using transplants have been developed to determine conditions necessary for establishment and growth. We hypothesized that 1) *A. gigantea* would have greater numbers of new shoots and greater growth (height) of new shoots when competition was controlled and 2) when fertilizer was applied. The third experiment tests the hypothesis that cane growth is limited by shading under full canopy forests. We hypothesized 3) new shoot numbers and growth would increase following canopy thinning.

Competition Experiment

Methods

Two separate sites of *Arundinaria gigantea* were established; Dahomey National Wildlife Refuge with eight plots, and Strawberry Plains Audubon Center with 21 plots. Each plot consists of sixteen plantings in a four by four array. Treatments were untreated controls and treated with an application of landscape fabric and hay mulch around the plantings. Measurements were taken on new shoot height (meter), new shoot diameter (millimeter), new shoot number, and survival.

Analysis

For survival, plantings within each treatment site were counted for analyses as either living, or dead. Total number of new stems, stem diameters, and stem heights were averaged for each treatment plot at each site prior to analyses. A one-way Analysis of Variance (ANOVA) (DNWR: n=4; SPAC: n=10) was performed for each hypothesis: 1) there was no change in the relative percentages of survival following application of the landscape fabric, 2) there was no change in the relative number of new shoots following application, and 3) there was no difference in stem diameter or stem height for one growing season following application (analysis of only 2004 data). Data was analyzed separately for each of the sites due to the difference in sample size. Alpha level was set at 0.1 due to low sample sizes and high variability.

Results & Interpretation

Hypothesis 1: There was no change in the relative percentages of survival following application of the landscape fabric to plots.

We found no significant difference between the percentage of survival in the control group when compared to the treatment group at SPAC or at DNWR (Table 1, Figure 1a), suggesting no competitive effect on transplant survival.

Hypothesis 2: There was no change in the relative number of new shoots following application of landscape fabric.

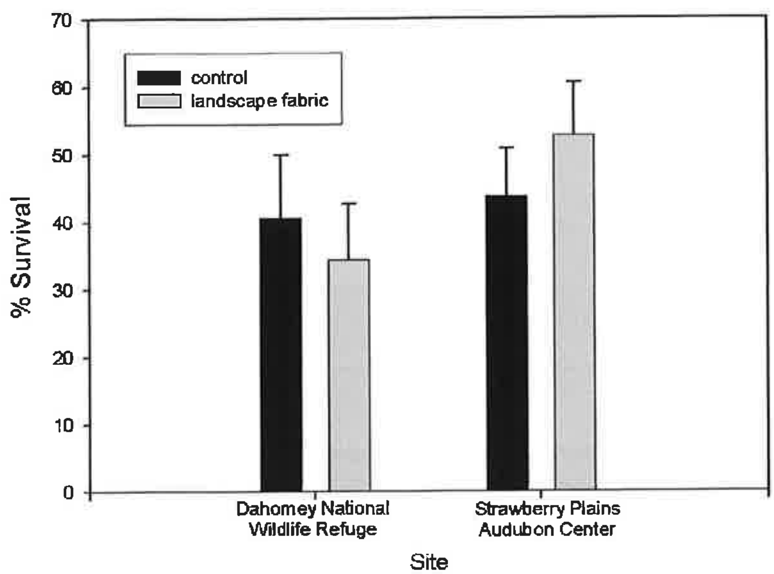
We found no significant difference in the total number of new shoots in the control group when compared to the treatment group at SPAC or at DNWR (Table 1, Figure 1b). However, when competition results were compared in 2003, (results were based on plants within plots and therefore not comparable to 2004 plot-based results) new shoot growth was greater in the plants treated with landscape fabric at SPAC only. Results at DNWR did not show a significant difference and could have been attributed to several factors, including difference in overall maintenance of the sites. Sites at SPAC were regularly maintained by mowing area around plots and weeding around plants with landscape fabric application.

Hypothesis 3: There was no difference in stem diameter or stem height one growing season following application of landscape fabric.

We found no significant difference in the mean or maximum new shoot diameter and, and no significant difference in mean or maximum new shoot height in the control group compared to the treatment group at SPAC and at DNWR (Table 1, Figure 2 and 3). These results suggest there was no effect of landscape fabric application treatment which does not support our hypothesis.

Table 1. ANOVA results from *Arundinaria gigantea* stem data collected from two sites (one from Dahomey National Wildlife Refuge and one from Strawberry Plains Audubon Center) comparing control and landscape fabric application treatments. Percent survival is based on mean percentage of live stems in each plot at each site. Total number of new shoots is based on the mean number of new shoots in each plot at each site. New shoot diameter and new shoot height were based on mean values and on maximum values in each plot at each site.

Test	F value	ρ > F
Percent Survival (2004)		
DNWR	0.250	0.635
SPAC	0.740	0.401
Total number of new shoots		
DNWR	0.018	0.897
SPAC	0.091	0.766
Mean 2004		
DNWR		
New shoot diameter	0.275	0.619
New shoot height	0.174	0.691
SPAC		
New shoot diameter	0.765	0.393
New shoot height	1.443	0.244
Maximum 2004		
DNWR		
New shoot diameter	0.266	0.624
New shoot height	0.124	0.737
SPAC		
New shoot diameter	0.143	0.710
New shoot height	0.602	0.448



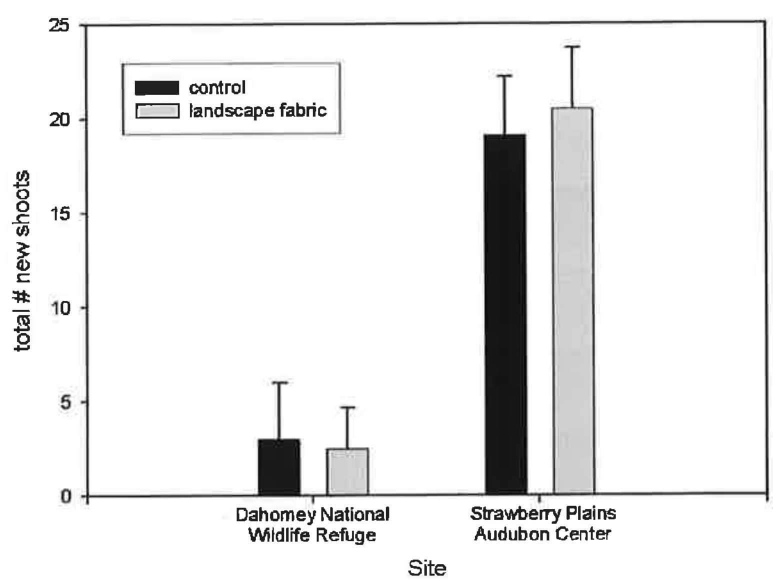
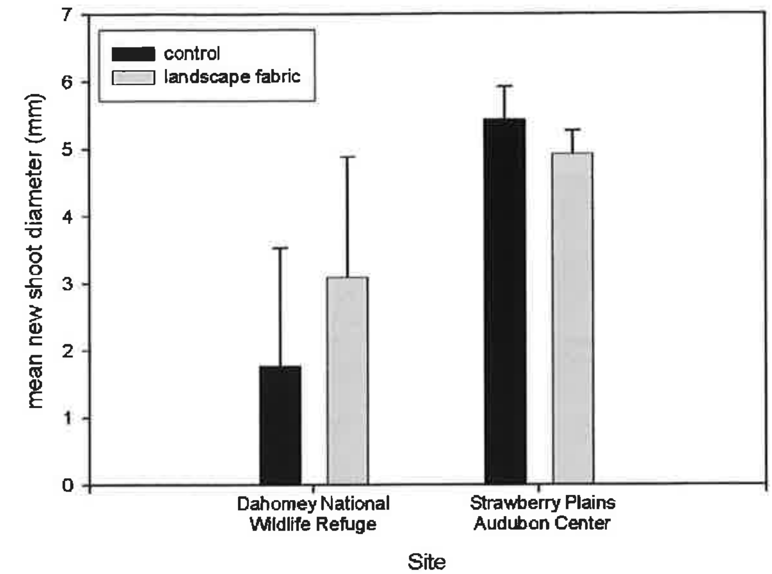


Figure 1. One growing season (2004) in survival (top graph) and total number of new shoots (bottom graph) by treatment from two sites, one at Dahomey National Wildlife Refuge, MS, and one at Strawberry Plains Audubon Center, MS comparing the effects of landscape fabric application. Error bars are standard error.



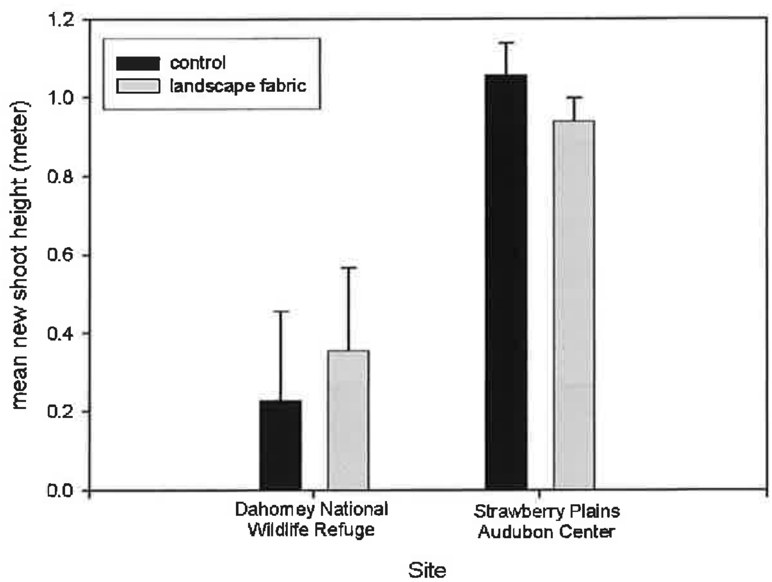


Figure 2. Difference (2004) in mean new shoot diameter (top graph) and mean shoot height (bottom graph) by treatment from two sites, one at Dahomey National Wildlife Refuge, MS, and one at Strawberry Plains Audubon Center, MS comparing the effects of landscape fabric application. Error bars are standard error.

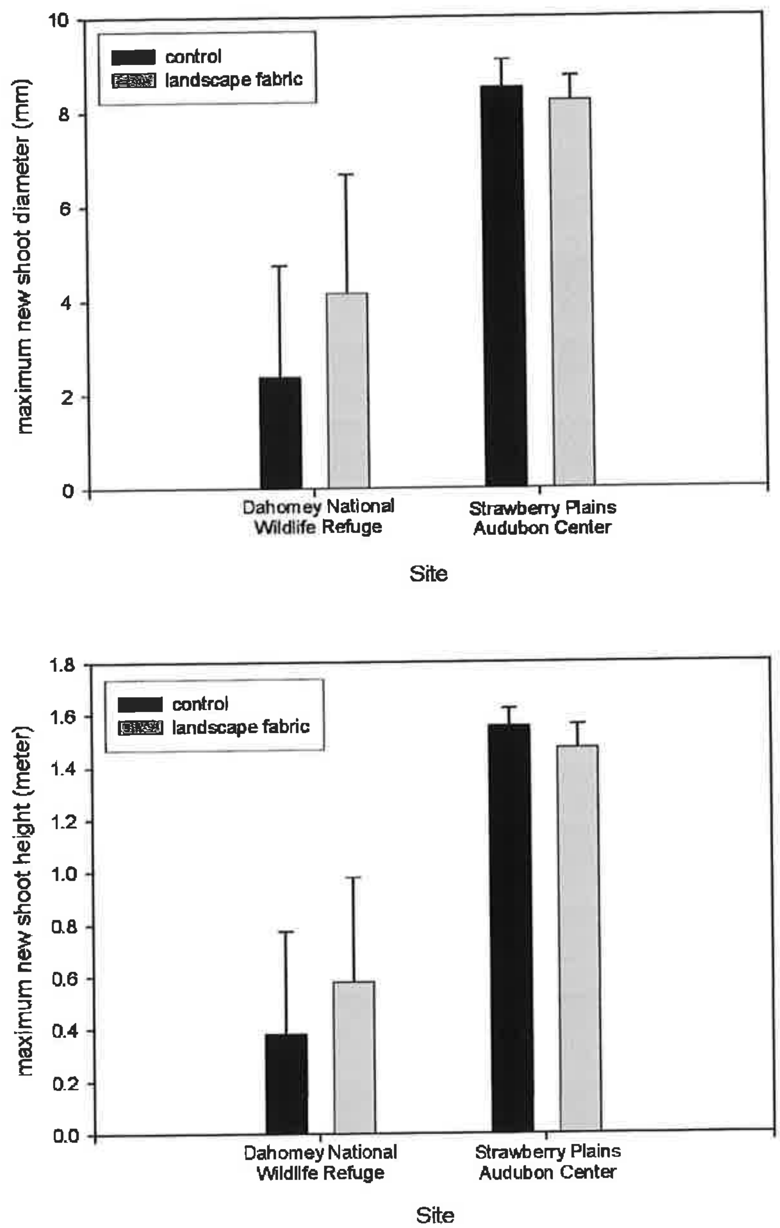


Figure 3. Difference (2004) in maximum new shoot diameter (top graph) and maximum shoot height (bottom graph) by treatment from two sites, one at Dahomey National Wildlife Refuge, MS, and one at Strawberry Plains Audubon Center, MS comparing the effects of landscape fabric application. Error bars are standard error.

Nutrient Experiment

Methods

Two sites were chosen; one at Strawberry Plains Audubon Center (SPAC – established 27Feb04) and one at Dahomey National Wildlife Refuge (DNWR-established Feb2004). Each site contained two treatment areas, one control and one with fertilizer applied (Osmacote); SPAC applications 25May04 and DNWR application 10May04. The SPAC site had two additional applications, nitrogen only and phosphate only. In the spring of 2004, 32 plots (n=8) were established at SPAC and ten plots (n=5) established at the Dahomey site. Sixteen plants were placed in each plot. The plants were allowed to establish approximately ten weeks prior to treatment.

Analysis

For survival, plantings within each treatment site were counted for analyses as either living, or dead. Total number of new stems, stem diameters, and stem heights were averaged for each plot at each treatment site prior to analyses. A one-way Analysis of Variance (ANOVA) (DNWR: n=5; SPAC: n=8) was performed for each hypothesis: 1) There was no difference in the relative percentages of survival of existing culms following application of the fertilizer, 2) there was no difference in the total number of new shoots following application, and 3) there was no difference in stem diameter or stem height for one growing season following application (analysis of only 2004 data). Alpha level was set at 0.1 due to low sample sizes and high variability.

Results & Interpretation

Hypothesis 1: There was no change in the relative percentages of survival of existing culms following application of the fertilizer.

We found no significant difference between the percentage of survival in the control group when compared to the treatment group at SPAC and at DNWR (Table 1, Figure 1a and 3a).

Hypothesis 2: There was no change in the relative number of new shoots following treatment.

We found no significant difference between the total number of new shoots in the control group when compared to the treatment group at SPAC and at DNWR (Table 1, Figure 1b and 3b). However, there appears to be an increase in the new shoots treated with phosphate and Osmacote. Although this observation is not statistically significant (ρ=0.133) and only found at SPAC, it does indicate a potential effect.

Hypothesis 2: There was no difference in stem diameter or stem height for one growing season following application

We found no significant difference between new shoot stem diameter or new shoot stem height in the control group when compared to the treatment group at SPAC and at DNWR (Table 1, Figure 2 and 4). Both of these variables followed the same pattern as seen with the total number of new shoots; again, with no statistical significance and only at SPAC. This difference was much less, but new shoot diameter and height were slightly increased in phosphate and Osmacote treated plots.

Table 1. ANOVA results from *Arundinaria gigantea* stem data collected from two sites (one from Dahomey National Wildlife Refuge and one from Strawberry Plains Audubon Center) comparing control and fertilizer treatments. Percent survival is based on mean percentage of live stems in each plot at each site. Total number of new shoots is based on the mean number of new shoots in each plot at each site. New shoot diameter and new shoot height were based on mean values and on maximum values in each plot at each site.

Test	F value	p > F
Percent Survival (2004)		
DNWR	0.206	0.662
SPAC	0.165	0.919
Total number of new shoots (2004)		
DNWR	0.019	0.894
SPAC	2.023	0.133
Mean values (2004)		
DNWR		
New shoot diameter	0.780	0.403
New shoot height	0.215	0.655
SPAC		
New shoot diameter	0.270	0.847
New shoot height	0.436	0.729
Maximum values (2004)		
DNWR		
New shoot diameter	0.212	0.658
New shoot height	0.002	0.968
SPAC		
New shoot diameter	1.184	0.334
New shoot height	0.665	0.580

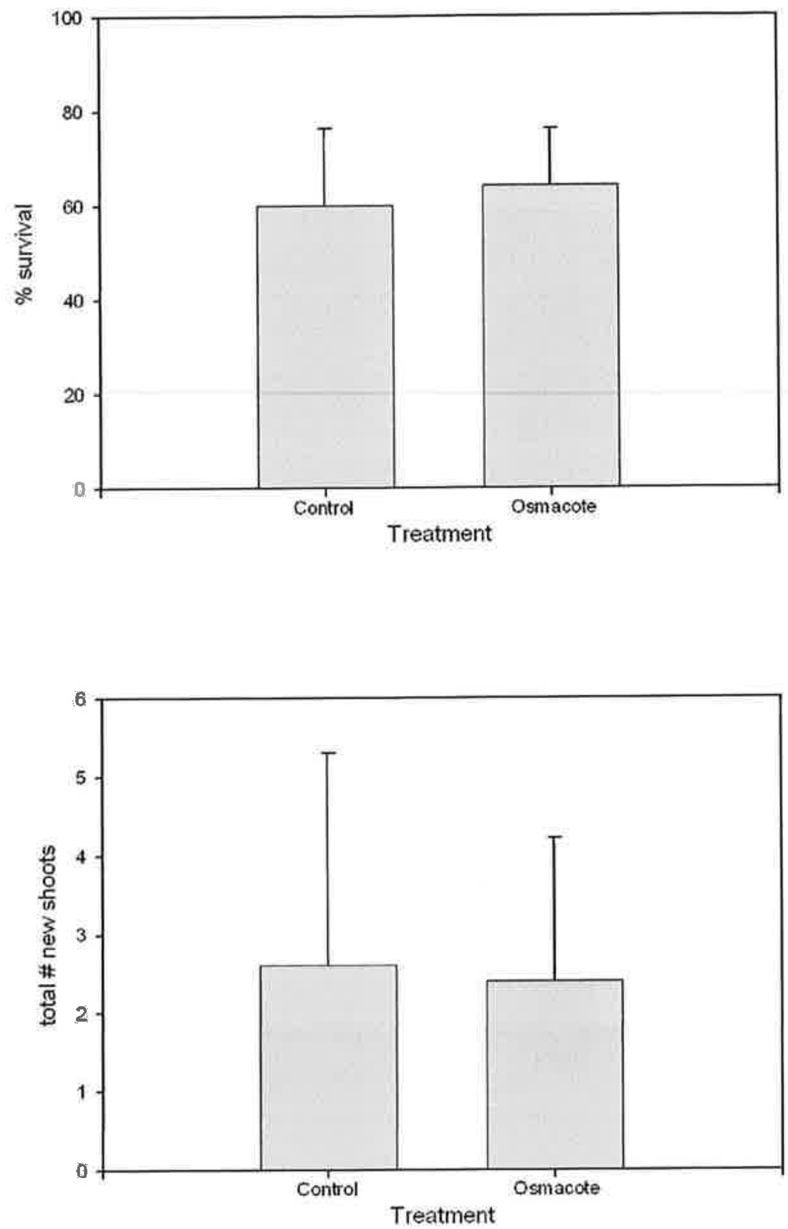


Figure 1. One growing season (2004) in survival (top graph) and total number of new shoots (bottom graph) by treatment from Dahomey National Wildlife Refuge, MS, comparing the effects of fertilizer application. Error bars are standard error.

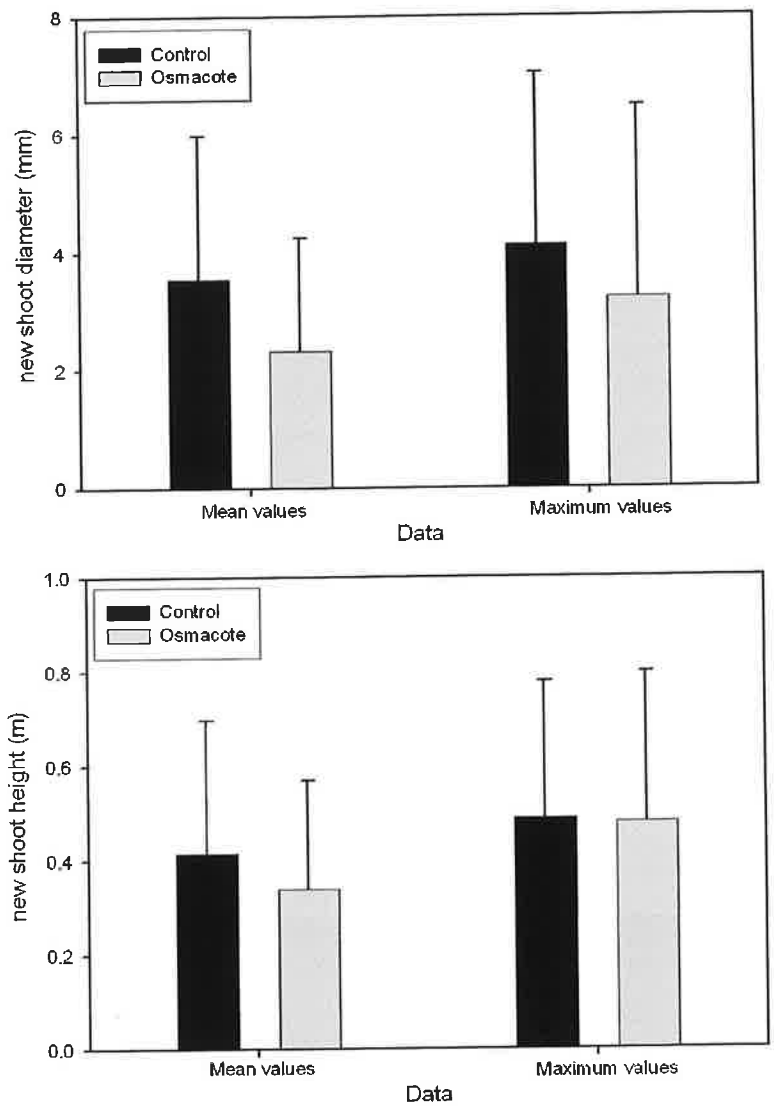
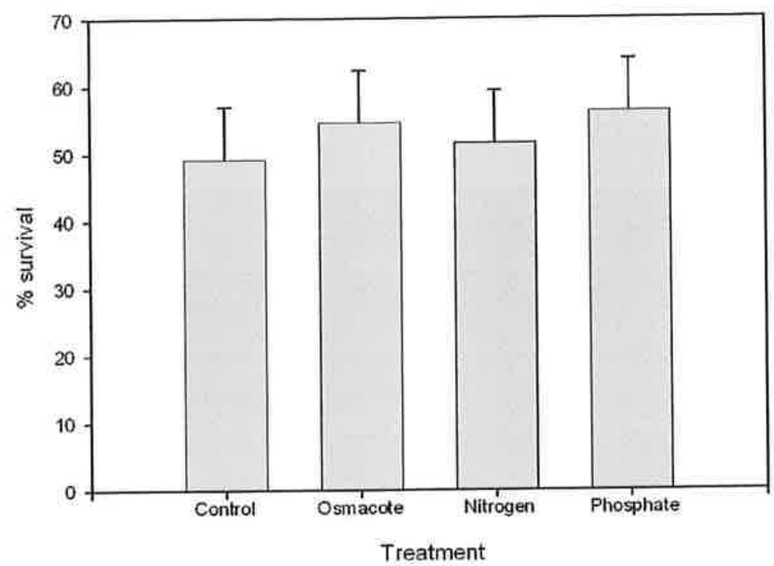


Figure 2. Difference (2004) in total new shoot diameter (top graph) and total new shoot height (bottom graph) by treatment from Dahomey National Wildlife Refuge, MS, comparing the effects of fertilizer application. Graphs show values expressed as both mean and maximum. Error bars are standard error.



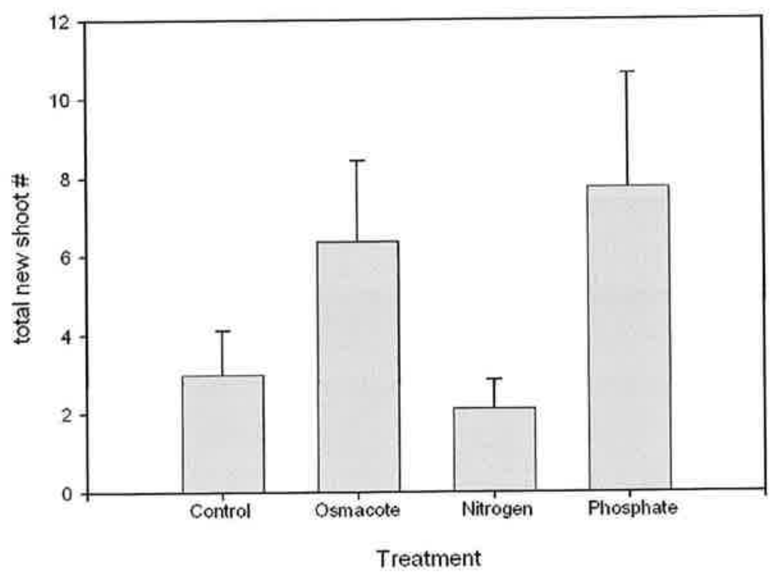
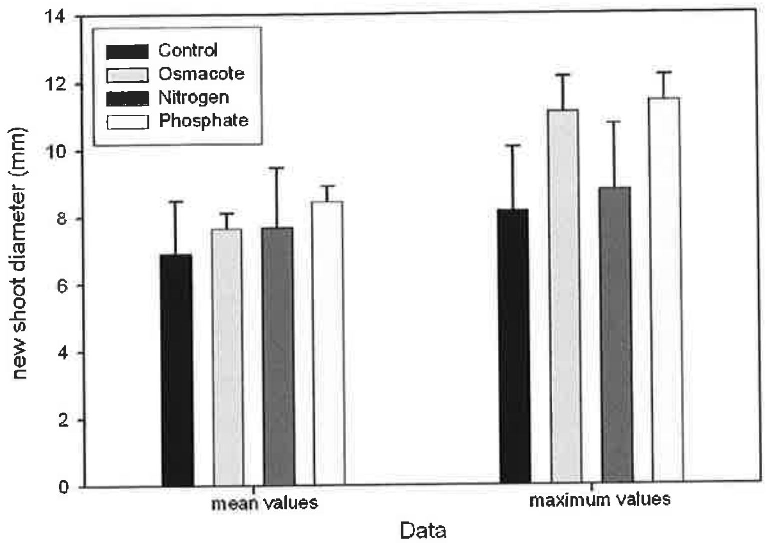


Figure 3. Difference (2004) in survival (top graph) and total number of new shoots (bottom graph) by treatment from Strawberry Plains Audubon Center, MS, comparing the effects of three different fertilizer applications. Error bars are standard error.



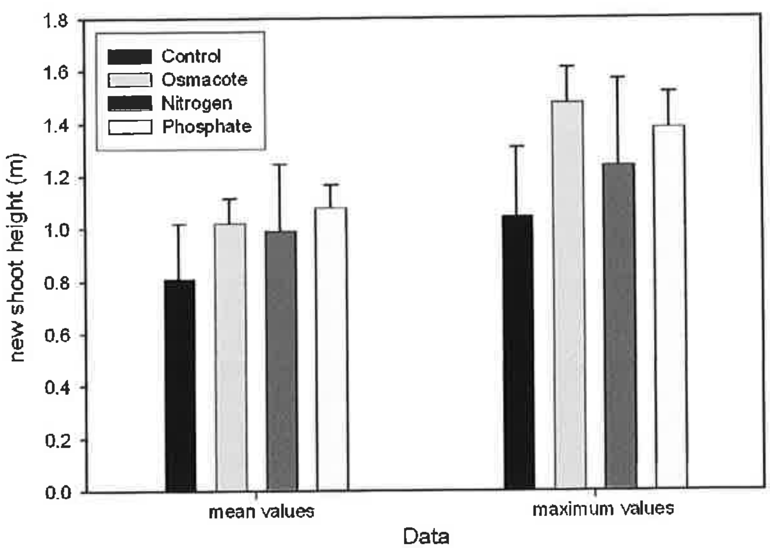


Figure 4. Difference (2004) in total new shoot diameter (top graph) and total new shoot height (bottom graph) by treatment from Strawberry Plains Audubon Center, MS, comparing the effects of different fertilizer applications. Graphs show values expressed as both mean and maximum. Error bars are standard error.

Thinning Experiment

Methods

Three sites were chosen; two at the Meeman Biological Field Station and one at Dahomey National Wildlife Refuge. Each site contained two treatment areas, one control and one with the canopy thinned by ~50%. In the fall of 2003, twelve plots were established in each treatment area at the Meeman Field Station and 20 sites established at the Dahomey site. In each plot, all stems of *Arundinaria gigantea* were classified as new shoot (<1 year old), culm (>1 year old), or dead. Stems were measured to the nearest 0.1 mm. Thinning was performed during the 2004 winter (Jan-Feb). Post-treatment data collection occurred in November 2004.

Analysis

For stem density, stems within each treatment site were summed for analyses by stem type: 1) new shoot (< 1 year old), 2) culm (> 1 year old), and 3) dead. Stem diameters and heights were averaged for each treatment site prior to analyses. Time 1 data were subtracted from Time 2 data to represent annual change. A paired t-test (n=3) was performed for each hypothesis: 1) there was no difference in the change of stem density or average stem diameter following thinning of the canopy, 2) there was no change in the relative percentages of new shoots, culms, or dead stems following thinning, and 3) there was no difference in stem densities, stem diameter, or stem height one growing season following thinning (analysis of only 2004 data). Alpha level was set at 0.1 due to low sample sizes and high variability.

Results & Interpretation

Hypothesis 1: Canopy thinning had no effect on the change of stem density or diameter.

We found no significant differences in culm density changes from 2003 to 2004 for any of the stem types (Table 1, Fig. 1a). However, the density of total stems increased on control sites, albeit most of these stems were dead, Fig. 1a), and decreased on thinned sites, resulting in a significant difference (Table 1). Also, change of both dead culm diameter and new shoot diameter were significantly different (Table 1), with thinning sites increasing in diameter and control sites decreasing (Fig. 1b).

Table 1. Paired t-test results from *Arundinaria gigantea* stem data collected from three sites (two at Edward J. Meeman Biological Field Station and one from Dahomey National Wildlife Refuge) comparing control and thinning (forest canopy thinned by 50%) treatments. Stems were split into new shoots (<1 year old), culms (>1 year old), and dead. Raw change data are the difference between data collected prior to treatments in 2003 and data collected one growing season following treatments in 2004. Relative change are the same but data are either relativized to percentage of total stems (total) or percentage of live stems (live).

Test	t value	p > t
Raw Change (2003-2004)		
Dead	2.26	0.152
Dead diameter	-4.04	**0.056**

New Shoot	0.25	0.826
New Shoot diameter	-12.90	**0.006**
Culm	-0.01	0.992
Culm diameter	-1.44	0.285
Total stems	6.21	**0.025**
Relative Change (2003-2004)		
Dead total	1.50	0.272
New Shoot total	-0.42	0.717
New Shoot live	-0.21	0.851
Culm total	-0.95	0.444
Culm Live	-0.21	0.851
Raw 2004		
Dead	1.09	0.389
Dead diameter	-1.70	0.230
Dead height	-0.25	0.825
New Shoot	-0.96	0.437
New Shoot Diameter	-3.49	**0.073**
New Shoot Height	-2.07	0.174
Culm	0.01	0.995
Culm Diameter	-1.12	0.379
Culm Height	-1.44	0.287

Hypothesis 2: Canopy thinning had no effect on the relative percentages of new shoots, culms, or dead stems.

We found no significant treatment effect on the changes in relative stem densities (Table 1). The trends in data suggest thinned forests are increasing relative numbers of new shoots and decreasing relative numbers of dead and older shoots (Figure 2). We plan to follow these results for another year to see if these trends hold true.

Hypothesis 3: Canopy thinning has no effect on stem densities, stem diameter, or stem height one growing season following thinning (analysis of only 2004 data).

We found no significant stem density or stem height differences in the post-treatment data (Table 1). New shoot diameter was significantly great in the thinned treatments (Fig. 3b), and the trend was that new shoot density and height were also greater (Fig. 3a, c), albeit insignificant. Future data on these sites are needed to clarify these trends.

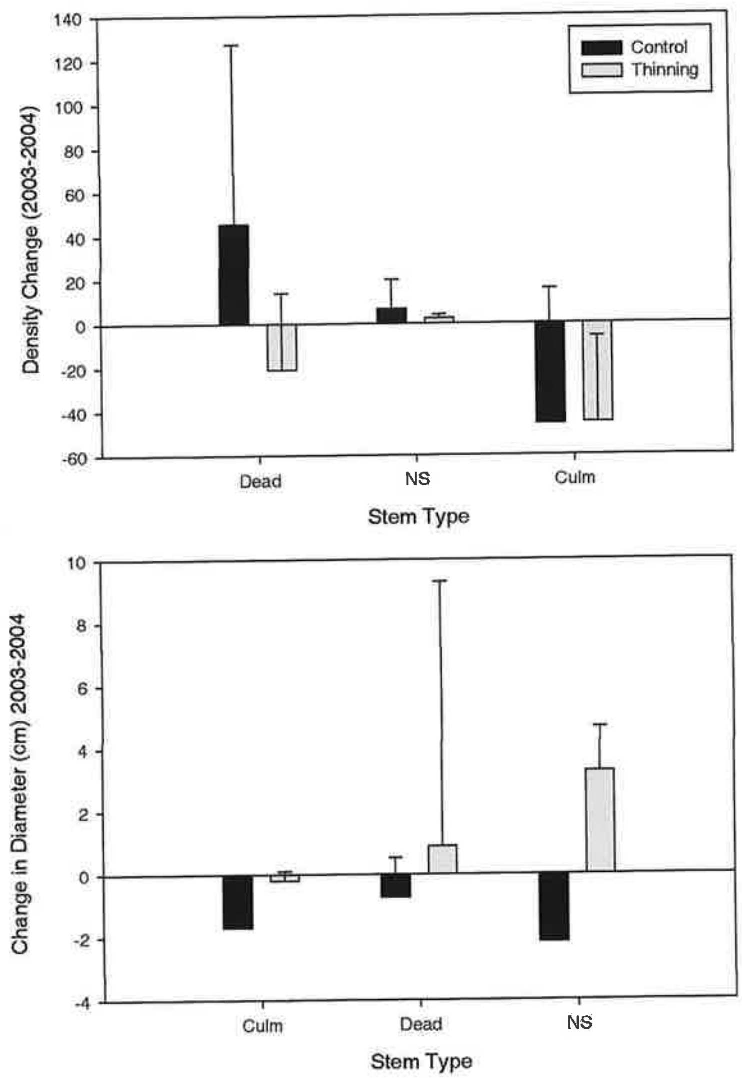


Figure 1. One growing season change (2003-2004) in density (top graph) and diameter (bottom graph) by stem type (Culm = stems > 1 year old; Dead = dead stems; NS = new shoots < 1 year old) from three sites, two at Edward J Meeman Biological Field Station, TN, and one at Dahomey National Wildlife Refuge, MS, comparing the effects of forest canopy thinning. Error bars are standard deviation.

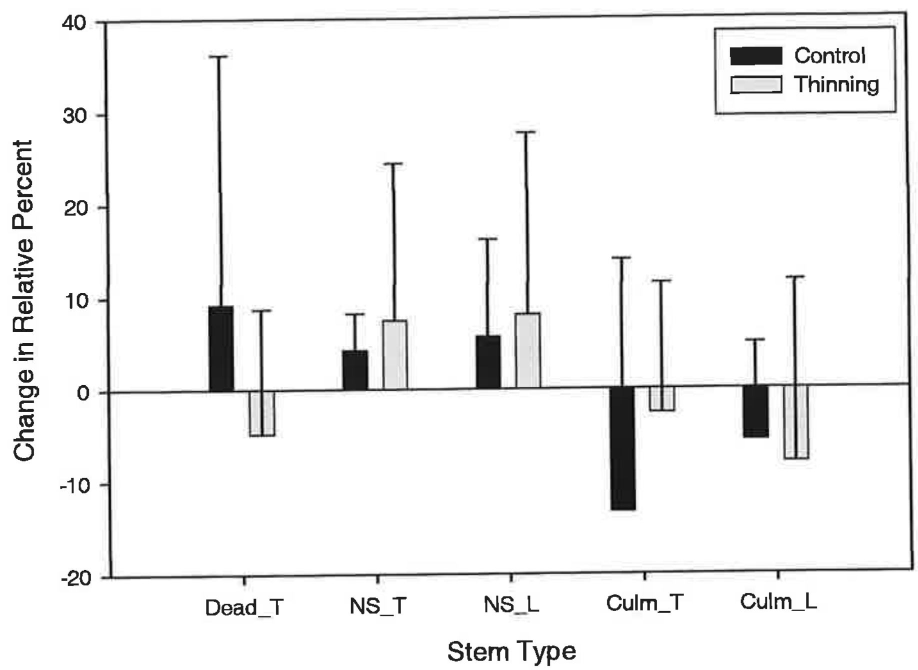


Figure 2. One growing season change (2003-2004) in relative density to total stems (T) and total live stems (L) by stem type (Culm = stems > 1 year old; Dead = dead stems; NS = new shoots < 1 year old) from three sites, two at Edward J Meeman Biological Field Station, TN, and one at Dahomey National Wildlife Refuge, MS, comparing the effects of forest canopy thinning. Error bars are standard deviation.

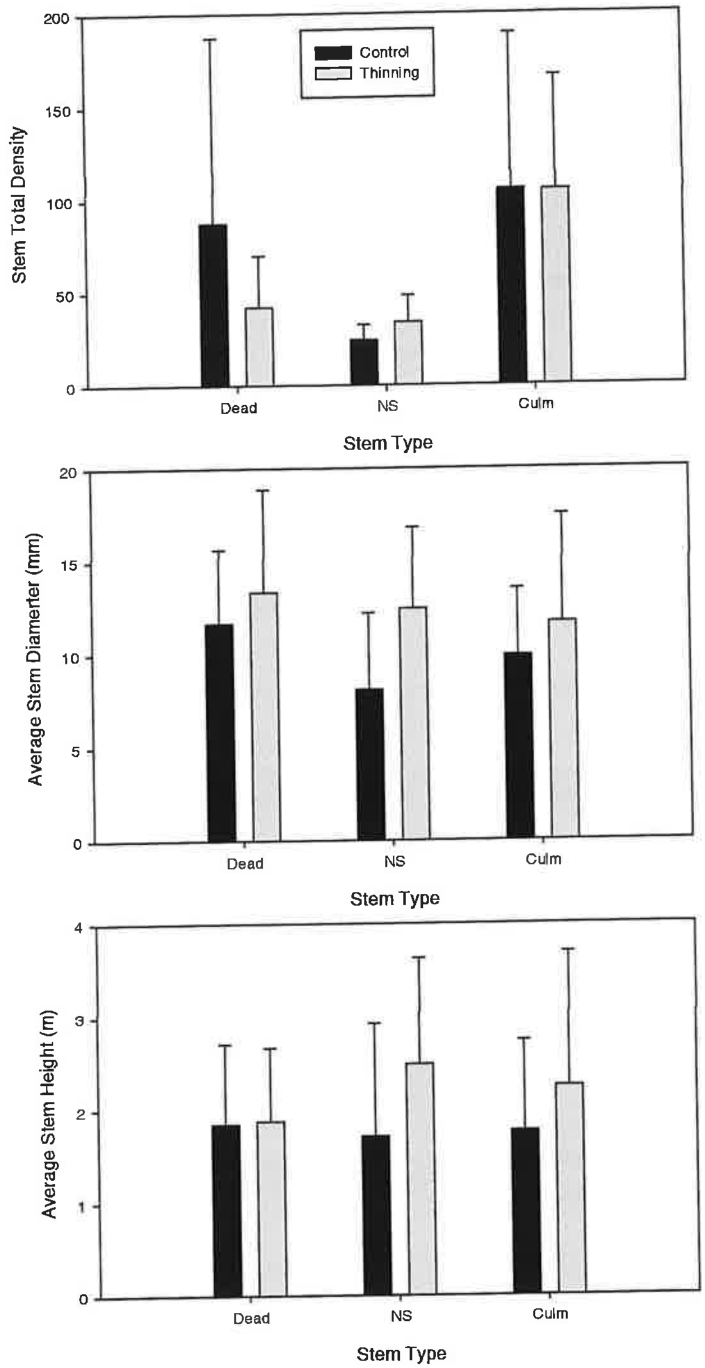


Figure 3. Total stem density, average stems diameter, and average stem height by stem type (Culm = stems > 1 year old; Dead = dead stems; NS = new shoots < 1 year old) from three sites, two at Edward J Meeman Biological Field Station, TN, and one at Dahomey National Wildlife Refuge, MS, comparing the effects of forest canopy thinning. Data were collected in November 2004, one growing season following thinning treatments. Error bars are standard deviation.

Conclusion

Our expected results for the studies at DNWR and SPAC were increased *A. gigantea* growth and survival with landscape fabric application, fertilization, and reduced forest canopy. However, following one season of growth our results did not support these expectations and several factors may have influenced these results. For both the competition and nutrient studies, weedy vegetation was a compounding factor. We plan to increase our efforts to control competition by applying additional landscape fabric and hay mulch as well as clipping around the plots to reduce vegetative encroachment.

Nutrient application was followed by frequent precipitation; potentially reducing fertilization effect on cane plots. Fertilization will be increased to a minimum of three applications for the nutrient studies to insure treatment levels will be higher.

While we know *A. gigantea* seedlings have increased growth in full sun conditions, the thinning sites did not reflect this as expected. Canopy thinning will need to be repeated to continue to increase light levels to the treatment sites. Site conditions will be analyzed by measuring light levels, soil moisture and temperature. Soil cores will also be analyzed. Monitoring site conditions may give us insight into potential environmental conditions impacting the results.

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